

Michigan Department of Environmental Quality
Air Quality Division



The State of Michigan's Analysis of
Interstate Transport of Fine Particulate Matter
for the 2012 PM_{2.5} NAAQS

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The purpose of this analysis is to supplement Michigan's Infrastructure State Implementation Plan (ISIP) for the 2012 Particulate Matter 2.5 (PM_{2.5}) National Ambient Air Quality Standard (NAAQS) submitted to the United States Environmental Protection Agency (USEPA) on July 10, 2014. Specifically, it fulfills the requirements of the Clean Air Act (CAA) Section 110(a)(2)(D)(i)(I), known as the "good neighbor provisions."

Summary

CAA Section 110(a)(2)(D)(i)(I) prohibits any state from emitting any air pollutant that "will contribute significantly to nonattainment in, or interfere with maintenance" of any other state's compliance with a NAAQS. This section of the CAA attempts to solve unique issues of air pollutants being emitted in one state and causing an impact in another state; i.e., interstate transport. With this ISIP supplement, the Michigan Department of Environmental Quality (MDEQ) is focused on the State of Michigan's contribution to any other state's compliance with the 2012 PM_{2.5} NAAQS annual standard. As part of the 2012 PM_{2.5} NAAQS, the USEPA retained the 24-hour standard; therefore, no ISIP is required for that standard and will not be addressed in this supplemental submittal. All references to the 2012 PM_{2.5} NAAQS in this submittal refer to the annual standard.

This analysis demonstrates that additional emission reductions beyond existing and already planned controls are not warranted to mitigate Michigan's contribution to maintenance and nonattainment issues in downwind states. The following is a weight-of-evidence analysis that utilizes modeling performed by the USEPA as part of the Cross State Air Pollution Rule (CSAPR) to quantify Michigan's emissions impact on downwind monitors. The calculated impact concentration is then compared to USEPA's significant impact level guidance. Meteorology, emission trends, ambient monitoring trends and upcoming regulations, as well as probable changes at Michigan sources are then described to complete the analysis.

Background

The USEPA issued a guidance memorandum ("Guidance") on March 17, 2016, addressing the good neighbor provisions for the 2012 PM_{2.5} NAAQS. This Guidance reiterates use of the four-step framework previously established for addressing interstate transport. As part of this four-step framework, the USEPA identifies downwind states that are expected to have maintenance or attainment issues, and identifies which upwind states contribute to these issues in amounts sufficient to warrant further review. After the analysis, upwind states must address their contributions through a weight-of-evidence analysis. The weight-of-evidence analysis should identify upwind emissions reductions necessary to prevent the upwind state from contributing to the issue, and should include additional factors such as meteorological, emissions, and monitoring data. Upwind states that are found to contribute significantly to nonattainment or interfere with maintenance of the NAAQS must describe permanent and enforceable measures to reduce their emissions.

Analysis

Identification of downwind nonattainment and maintenance receptors

The Guidance identifies projected maintenance and nonattainment receptors for the 2012 PM_{2.5} standard. Of the 19 projected nonattainment or maintenance receptors, 17 are located in California, one in Idaho, and one in Pennsylvania.

Identification of Michigan's contribution to maintenance and nonattainment sites

The Guidance assigns the states the responsibility to analyze their contributions to maintenance and attainment sites. As the Guidance is silent on an analysis method, the MDEQ is utilizing the screening threshold detailed in its January 2015 memorandum addressing interstate transport for the 2008 ozone standard.

The USEPA's 2008 Ozone Good Neighbor Memorandum states that, "CSAPR used a screening threshold (1 percent of the NAAQS) to identify contributing upwind states warranting further review and analysis. States whose air quality impact to at least one downwind problem receptor was greater than or equal to the threshold were identified as needing further evaluation for actions to address transport." Based on this 1% screening threshold, the MDEQ categorized Michigan's potential contribution into two groups: the California and Idaho Sites and the Pennsylvania Site.

This analysis specifically deals with transport of PM_{2.5} and its precursors from Michigan. PM_{2.5} is a unique pollutant because it is both emitted directly into the atmosphere (primary PM_{2.5}) and formed in the atmosphere (secondary PM_{2.5}) from precursor pollutants such as sulfur dioxide (SO₂) and oxides of nitrogen (NO_x), including nitrogen dioxide (NO₂). Secondary PM_{2.5} precursors require time to react and form fine particulate, usually in the form of nitrates and sulfates. These reactions can take hours to days, unlike primary PM_{2.5} impacts, which are mostly determined by physical factors like stack height and downwash. Our analysis will describe Michigan's emission and ambient trends of PM_{2.5}, NO_x and SO₂ though it's likely only NO_x and SO₂ (precursor) emissions could affect the relevant receptor sites in other states.

California and Idaho Monitor Sites

The nearest point in California to Michigan is approximately 1,500 miles. The closest point in Michigan to Idaho is Michigan's Upper Peninsula. The closest distance between the westernmost point of Michigan's Upper Peninsula and the easternmost portion of Idaho is approximately 1,000 miles. These distances make it highly unlikely that Michigan's emissions of PM_{2.5} or its precursors would have any measurable impact on the sites in these states. Also, synoptic scale air masses and weather patterns in the United States generally travel from west to east due to the jet stream, which would also make it highly unlikely that Michigan, a state in the eastern half of the country, would have an impact on a state in the far western half. For these reasons, it is the MDEQ's contention that the state of Michigan has no impact on these 18 maintenance or attainment sites, and concludes that no further analysis is required to comply with the ISIP good neighbor provisions for the 2012 PM_{2.5} NAAQS for these sites.

Pennsylvania Site

In Pennsylvania, one of several Allegheny County monitors, site number 420030064, also known as the “Liberty” site (Liberty), is projected to be in maintenance status by 2017 for the 2012 PM_{2.5} NAAQS. According to the Guidance, this monitor was modeled to have a maximum PM_{2.5} design value of 12.16 µg/m³ and an average design value of 11.67 µg/m³ in 2017. The MDEQ contends that transport of NO_x, SO₂ and PM_{2.5} from Michigan will be minimal and not interfere with Pennsylvania’s ability to maintain the 2012 PM_{2.5} NAAQS at this monitor in 2017 and beyond.

To estimate Michigan’s average contribution to the Liberty monitor, the MDEQ used the value specified in the 2012 CSAPR air quality modeling technical support document in which contributions of PM_{2.5} from each state were determined for each monitoring site for the 2006 annual PM_{2.5} standard. This average contribution of 1.8% (Table 1) represents the percentage of PM_{2.5} that Michigan was contributing to the Liberty monitor for 2012.

Table 1. Michigan's Modeled 2012 PM_{2.5} Contribution to Liberty Monitor

Monitor Site ID, State and County	2012 Base Case Annual PM _{2.5} Average Design Value (µg/m ³)	2012 Base Case Annual Maximum Design Value (µg/m ³)	MI Contribution Annual PM _{2.5} (µg/m ³)	MI Calculated Average Contribution (%)
420030064 Pennsylvania Allegheny	17.94	18.33	0.331	1.8

*Shaded area is an excerpt from the USEPA’s 2012 CSAPR air quality modeling technical support document.

The MDEQ used this calculated 1.8% contribution and applied it to the average and maximum projected 2017 PM_{2.5} design values listed in the Guidance. The result is Michigan’s estimated contribution to the Liberty monitor in 2017 for the 2012 PM_{2.5} NAAQS of 0.21 µg/m³ (Table 2).

Table 2. Michigan's Projected 2017 PM_{2.5} Contribution to Liberty Monitor

Monitor Site ID, State and County	Average Annual PM _{2.5} Design Value 2017 (µg/m ³)	Maximum Annual PM _{2.5} Design Value 2017 (µg/m ³)	MI Calculated Average Contribution from 2012 CSAPR/Table 1 (%)	MI Calculated Contribution to Liberty Monitor (µg/m ³)
420030064 Pennsylvania Allegheny	11.67	12.16	1.8	0.21

*Shaded area is an excerpt from the USEPA’s 2016 Good Neighbor Guidance for 2012 PM_{2.5}.

Michigan's $0.21 \mu\text{g}/\text{m}^3$ calculated contribution to the Liberty monitor is well below the $0.3 \mu\text{g}/\text{m}^3$ commonly used as a significant impact level (SIL) for permitting purposes. The 2016 draft guidance from the USEPA, *Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program*, has suggested that while values greater than $0.3 \mu\text{g}/\text{m}^3$ are significant, impacts below $0.2 \mu\text{g}/\text{m}^3$ are "insignificant and should be considered to not cause or contribute to any violation of the annual $\text{PM}_{2.5}$ NAAQS that is identified." Discretion is left to permitting authorities on a case-by-case basis for values between 0.2 and $0.3 \mu\text{g}/\text{m}^3$. If Michigan was a stationary source subject to the Prevention of Significant Deterioration program going through a permitting process, it could be argued that the state should be considered an insignificant source.

However, Michigan's estimated contribution of 1.8% ($0.21 \mu\text{g}/\text{m}^3$) is greater than the 1% of the $12 \mu\text{g}/\text{m}^3$ standard threshold ($0.12 \mu\text{g}/\text{m}^3$) that the USEPA has used in the past to determine contribution levels that require further analysis and potential emission reductions. Therefore, further analysis is necessary to show Michigan's estimated $0.21 \mu\text{g}/\text{m}^3$ contribution to the Liberty monitor will not impact their ability to achieve and maintain the standard.

Identification of Michigan emissions reductions necessary to prevent contribution to Pennsylvania monitor maintenance

It is unnecessary for Michigan to take additional steps to ensure its emissions do not interfere with the Liberty monitor's maintenance status. A weight-of-evidence approach is used in the following discussion to demonstrate this assertion.

Meteorology

As stated above, the closest point in Michigan is 150 miles from the Liberty monitor. Weather patterns and air masses over Michigan generally travel west to east or southwest to northeast in this region of the country. Figures 1 and 2 show wind roses using 2015 airport meteorology data illustrating that Michigan sources would not have significant impacts on the Liberty monitor. In Figures 1 and 2, Allegheny County is bordered in white while the Liberty monitor is shown as the yellow star in Figure 2.

Figure 1 shows wind roses from the Detroit Metropolitan, Port Huron, and Toledo airports. These three wind roses show the distribution of wind flows (direction and speed) towards those airports are predominately from the southwest. This indicates that winds in Michigan usually flow to the northeast, away from Allegheny County.

Figure 2 shows a wind rose from the Pittsburgh airport with wind flowing toward that location, mostly from a southwest direction. This means that wind flowing into the Allegheny County area usually comes from the southwest, not from Michigan. Together these figures indicate that emissions of $\text{PM}_{2.5}$ and its precursors from Michigan are not heavily impacting the Liberty monitor.

Figure 1. Detroit, Port Huron, and Toledo Airport Wind Roses

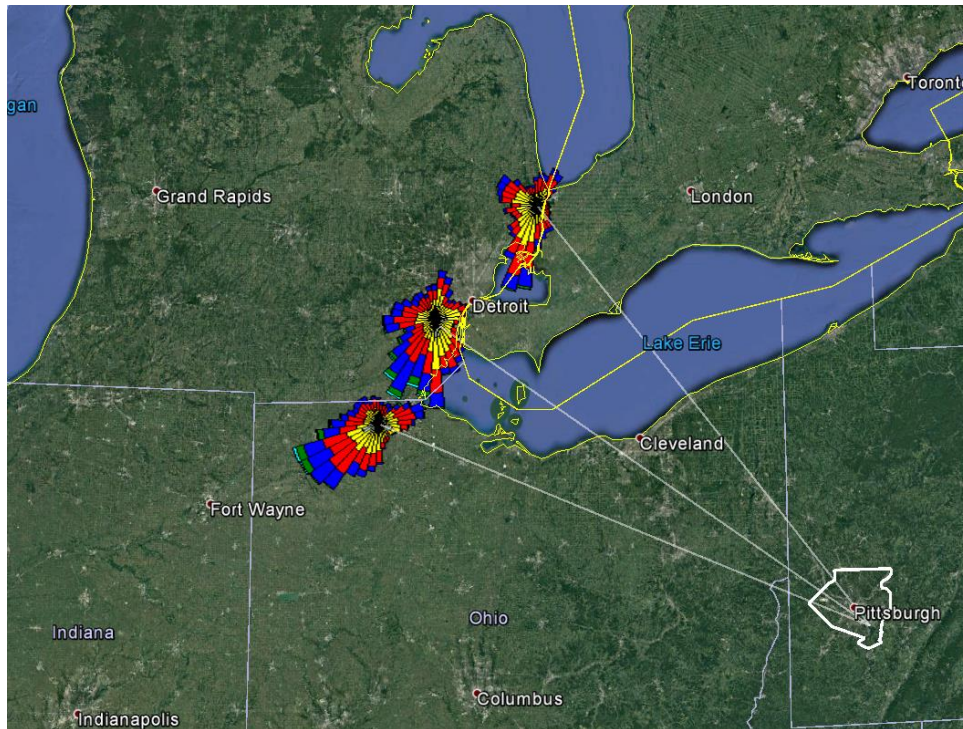
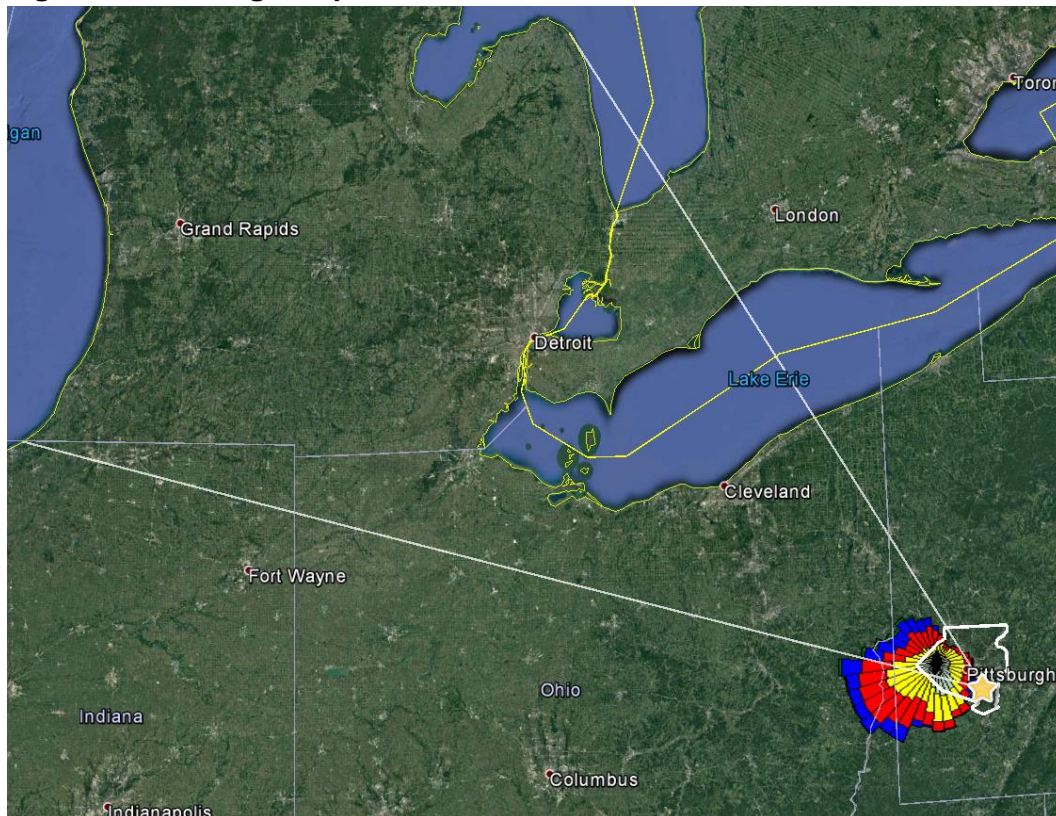


Figure 2. Pittsburgh Airport Wind Rose



The 2015 meteorological data used to create the wind roses in Figures 1 and 2 is also summarized in Table 3. This data indicates that winds flowing directly toward Allegheny County from southeast Michigan and northwestern Ohio constitute less than 5% overall flow to that area of Pennsylvania, thus strengthening the argument that emissions of PM_{2.5} and its precursors from Michigan are not heavily impacting the Liberty monitor.

Table 3. Meteorological Data - Wind Direction Distribution

Airport	Wind direction range toward Allegheny County (degrees)	Frequency (%)
Toledo, OH (TOL)	105-125	< 4.4
Port Huron (PHN)	135-155	<3.1*
Detroit (DTW)	125-145	<4.7

* Data set contained numerous “calms”

Emissions Trends

Figure 3 shows annual PM_{2.5}, NO_x, and SO₂ emissions from 2008 through 2014. The Michigan Air Emissions Reporting System (MAERS) tracks emissions in the state from industrial sources as reported by the sources themselves. The data in this system are quality-assured by the MDEQ. These data show a marked decline in SO₂ emissions and a slight decline in NO_x emissions from 2008 to 2014. The MAERS data also show an overall downward trend in PM_{2.5} emissions from 2010 to 2014. The National Emissions Inventory (NEI) data, which includes the MAERS sources as well as residential, biogenic, fire, and mobile sources, shows no increase in PM_{2.5} emissions and a sharp decline in NO_x and SO₂ emissions during the same period.

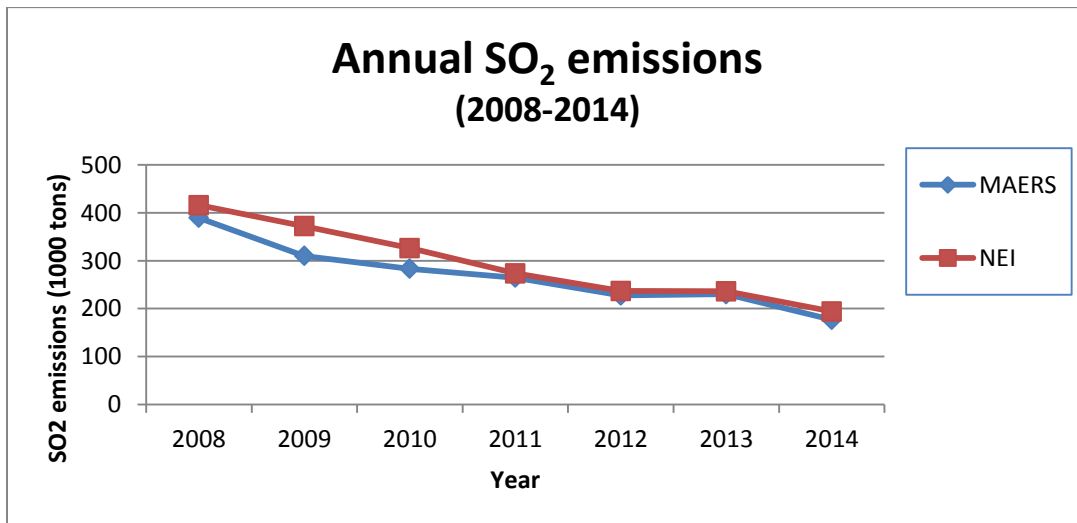
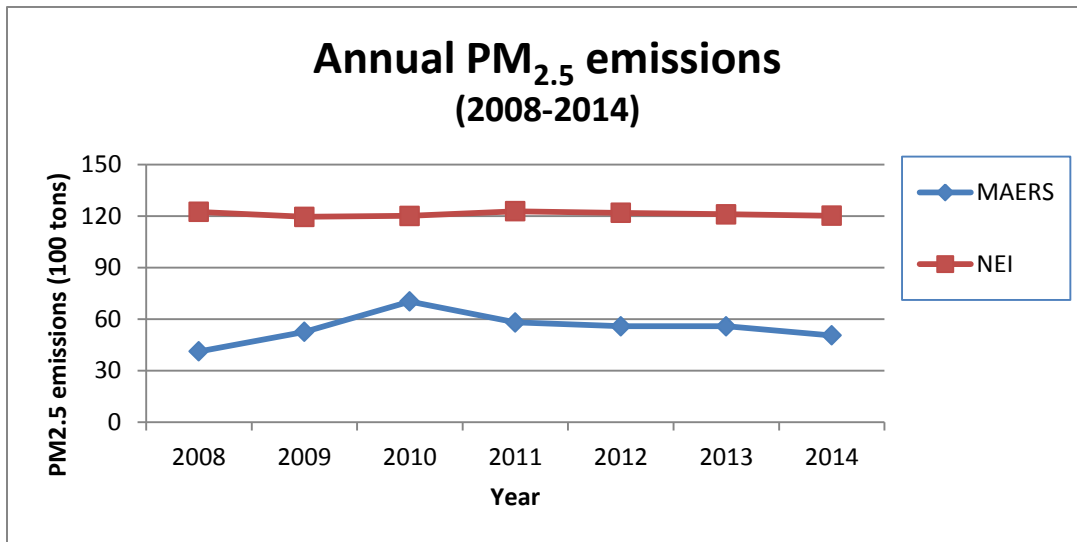
Table 4 shows the 5-year emission trends for NO_x, SO₂, and primary PM_{2.5} for both the NEI and MAERS data from 2010 to 2014. It includes the overall tonnage decrease as well as the percent change over the 5-year time frame. The data demonstrates double digit decreases in NO_x and SO₂, the pollutants that are most likely to travel the farthest. The NEI PM_{2.5} data is the only dataset that remained relatively flat, but again, primary PM_{2.5} is not likely to travel 150 miles from Michigan to impact the Allegheny site.

Michigan’s emissions are generally trending downward and should not impact the ability of the Liberty monitor to maintain the 2012 PM_{2.5} NAAQS. This downward trend also means that any future decreases in Michigan’s emissions will lead to a lesser impact by Michigan’s emissions on the Liberty monitor. Some of these future decreases in emissions include:

- NO_x and SO₂ reductions from 35 coal-fired power plant units scheduled to close by 2022, 20 of which are expected to be closed by 2018. Based on 2014 emissions data, approximately 9,800 tons of NO_x and 30,990 tons of SO₂ will be eliminated due to the retirement of these power plants in 2016.
- NO_x and SO₂ from the new USEPA Tier 3 fuel standards that are set to begin in 2017. Based on USEPA estimates, the standards will reduce NO_x and PM emissions by 70% in vehicles.

- Reductions of SO₂ from permit changes and Michigan R 336.1430. These require emission reductions for two coal-fired power plants and a steel facility as part of the Michigan SO₂ Attainment SIP for Wayne County for the 2010 SO₂ NAAQS. Implementation of this SIP is expected to result in more than 11,000 tons per year of SO₂ reductions.

Figure 3. Michigan's Annual PM_{2.5}, SO₂, and NO_x Emission Trends



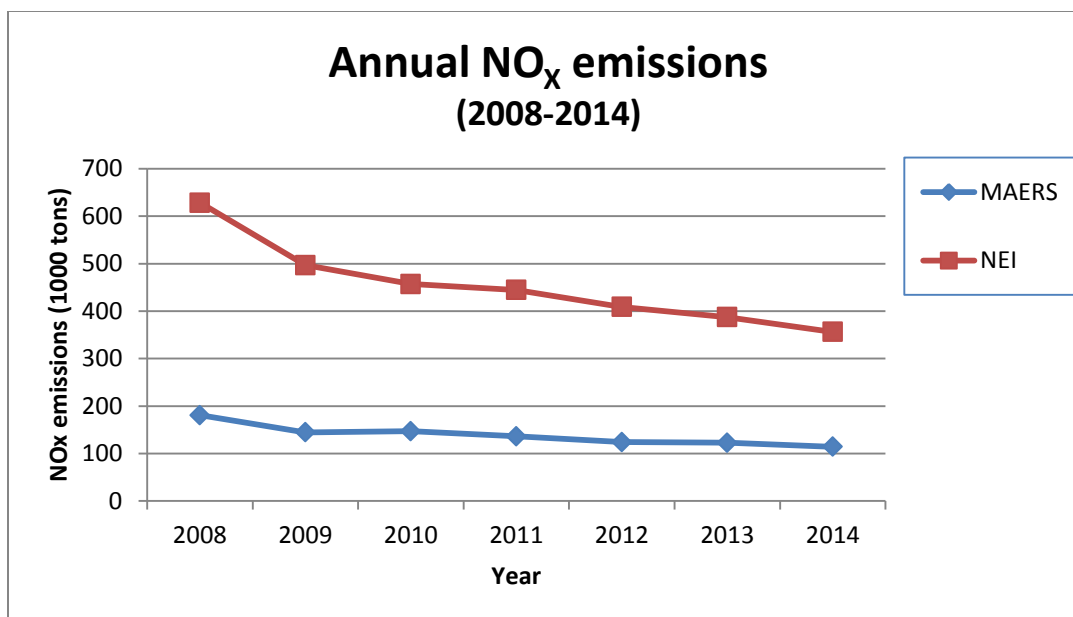


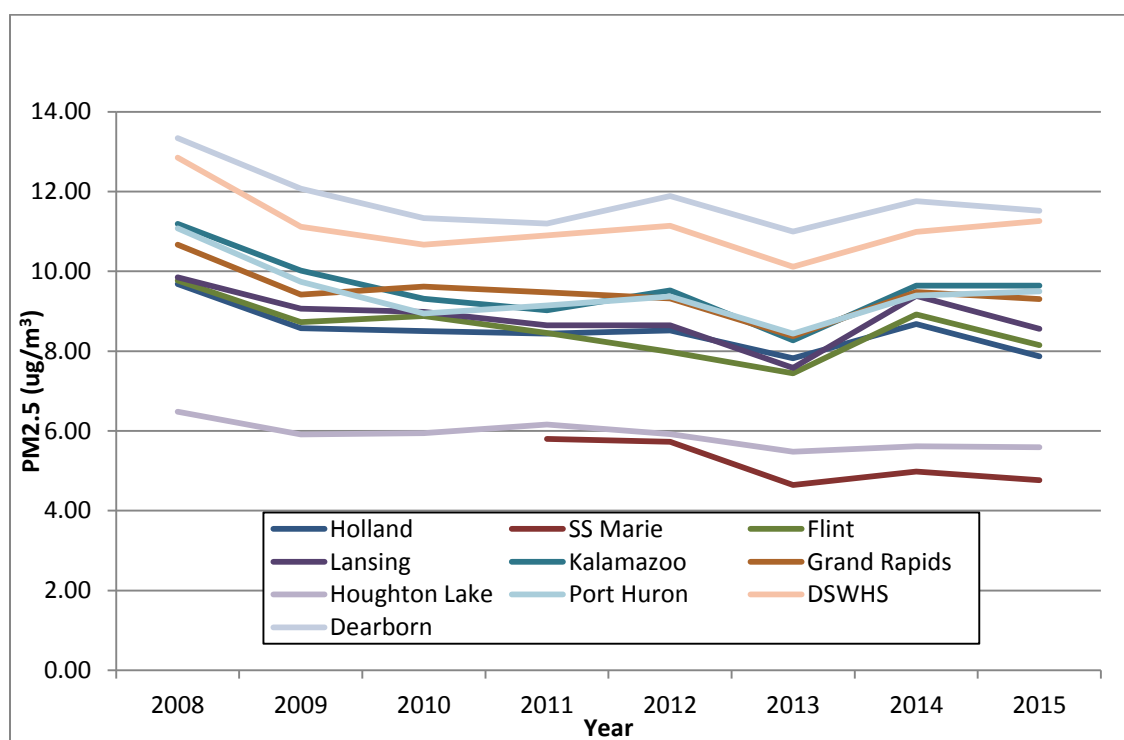
Table 4. Michigan's 5-year Emission Trends for NO_x, SO₂, and PM_{2.5}

	MAERS			NEI		
	NO _x (1,000 tons)	SO ₂ (1,000 tons)	PM _{2.5} (100 tons)	NO _x (1,000 tons)	SO ₂ (1,000 tons)	PM _{2.5} (100 tons)
2010	147	283	70.3	457	326	120.1
2014	114	177	50.6	356	194	120.2
Change	-33	-106	-19.7	-101	-132	+0.1
Percent Change	-22%	-37%	-28%	-22%	-40%	<+0.1%

Monitored Concentrations

Michigan's monitored values of PM_{2.5}, NO₂, and SO₂ have decreased or remained consistent from 2008 to the present. Figure 4 shows the annual PM_{2.5} monitored mean values from sites across the state. In 2008, Michigan's annual PM_{2.5} monitored mean values ranged from 6.48 to 13.92 µg/m³, and in 2015, the monitor values ranged from 5.59 to 11.65 µg/m³, a clear downward trend. Although two of the highest monitored values depicted in Figure 4 are located in southeast Michigan (Detroit Southwest High School [DSWHS] and Dearborn) nearest the Liberty monitor area, the wind roses in Figure 1 and Table 3 indicate the average wind flow around these monitors is rarely in that direction. This means that although these sites have elevated PM_{2.5} monitor values as compared to other Michigan sites, the PM_{2.5} emitted in the southeast Michigan area is most likely not impacting the Liberty monitor. Table 5 shows design values for ten sites across the state over a five-year period. Six sites show slight decreases, while four show slight increases. As stated above, those sites with increases would not be expected to impact the Liberty monitor based on the relatively short distance primary PM_{2.5} is thought to travel and the dominate wind directions.

Figure 4. PM_{2.5} Monitored Annual Mean Trends in Michigan



**Table 5. Michigan's 5-year Monitored Trends for Annual PM_{2.5}
(Annual Mean Values - µg/m³)**

	Holland	Sault Ste. Marie	Flint	Lansing	Kalamazoo	Grand Rapids	Houghton Lake	Port Huron	DSWHS	Dearborn
2011 Annual Mean	8.4	5.8	8.5	8.7	9.0	9.5	6.2	9.1	10.9	11.2
2015 Annual Mean	7.9	4.8	8.2	8.6	9.6	9.3	5.6	9.5	11.2	11.5
Change	-0.5	-1.0	-0.3	-0.1	+0.6	-0.2	-0.6	+0.4	+0.3	+0.3
Percent Change	-6%	-17%	-4%	-1%	+7%	-2%	-10%	+4%	+3%	+3%

The monitored SO₂ levels in Michigan are also on a downward trend since 2008 for some locations, while maintaining low levels for others (Figure 5). The 1-hour SO₂ data shows a decrease in the greatest measured concentrations from 101 ppb in 2008 to 76 ppm in 2015, with every other monitor, except the Port Huron monitor, well below 60 ppb in 2015. The Port Huron monitor is in an area that is designated as nonattainment for the 2010 SO₂ NAAQS. The main contributors to this nonattainment area are two facilities owned by one company that are expected to have emission reductions in the next few years as part of a new SO₂ Attainment SIP. These reductions in SO₂ emissions will not only help that area of Michigan achieve attainment, but will also reduce any minor impact Michigan is having on the Liberty monitor.

Table 6 also illustrates the SO₂ trends in Michigan by depicting the 99th percentile 1-hour daily SO₂ emissions at six monitors over the past five years. There is a combination of increases and decreases in the SO₂ monitored levels, but decreases appear to far outweigh increases in both percentage and change in monitored value.

Figure 5. 1-hour SO₂ Monitored 99th Percentile Trends in Michigan

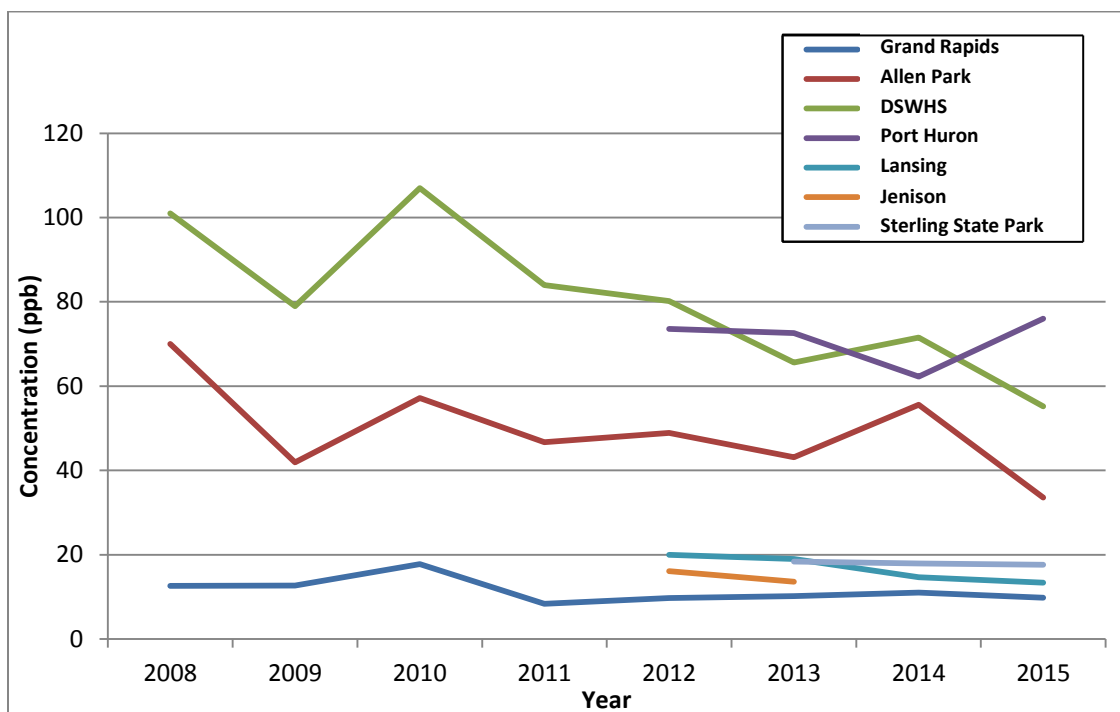


Table 6. Michigan's 5-year Monitored Trends for 1-hr SO₂ (99th Percentile values - ppb)

	Grand Rapids	Allen Park	DSWHS	Port Huron	Lansing	Sterling State Park
2011 99 th Percentile	8.4	46.7	84	73.6*	20*	18.4**
2015 99 th Percentile	9.8	33.6	55.2	76	13.4	17.6
Change	+1.4	-13.1	-28.8	+2.4	-6.6	-0.8
Percent Change	+16.7%	-28.1%	-34.3%	+3.2%	-33%	-4.3%

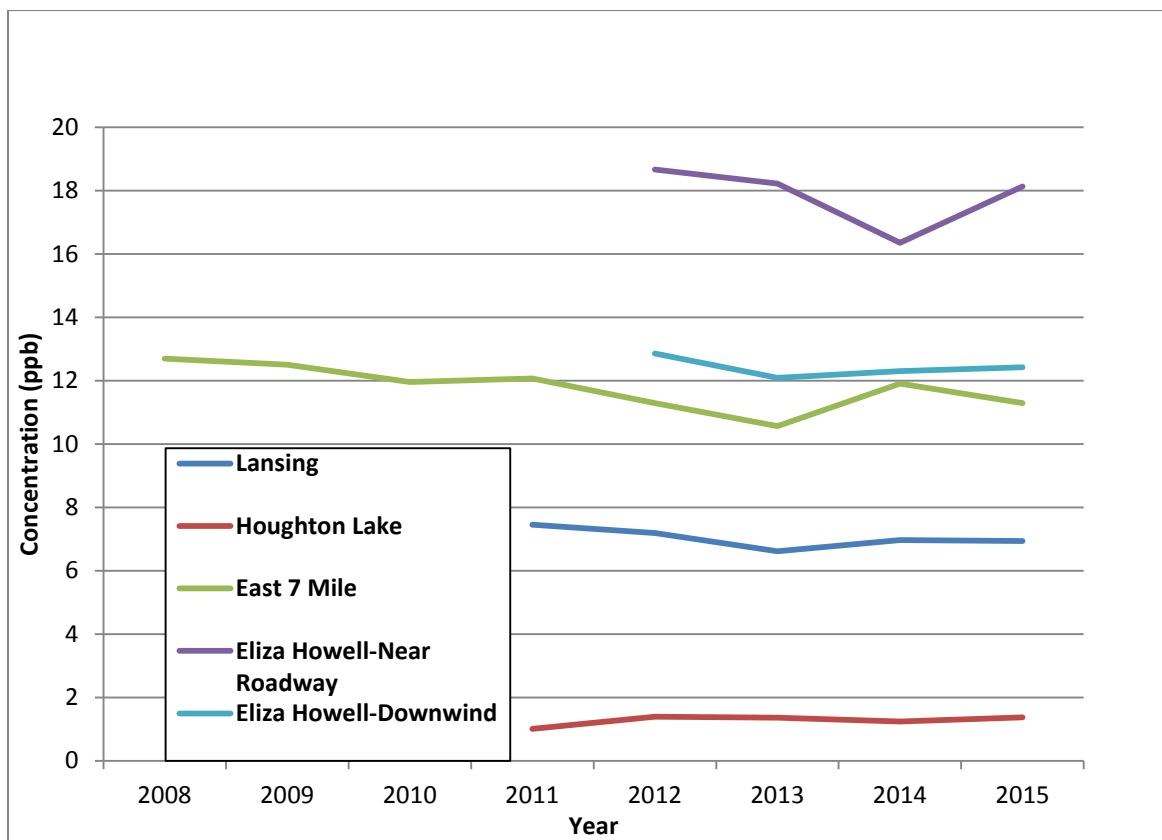
* 2012 99th percentile, 2011 data not available

** 2013 99th percentile, 2011 and 2012 not available

The monitored annual mean levels of NO₂ in Michigan seem to be relatively stable from 2008 to 2015 (Figure 6), demonstrating levels less than half the NAAQS standard of 53 ppb. The monitor with the longest trend, East 7 Mile, shows a downward trend that tracks with the MAERS downward trend of NO₂ emissions (Figure 3). This reinforces the assertion that any future reductions in NO₂ emissions will result in reductions in monitored NO₂ levels and any secondary PM_{2.5} transport to the Liberty monitor. Therefore, any future reductions of NO₂ from power plant shutdowns and Tier 3 fuel standards in Michigan could only have a positive effect

on the Liberty monitor. At a minimum, Michigan's NO₂ emissions impacts on the Liberty monitor are not expected to increase, thereby not interfering with their ability to maintain attainment. The five-year trend depicted in Table 7 shows Michigan's monitored annual NO₂ levels decreasing at four of five locations.

**Figure 6. NO₂ Monitored Trends in Michigan
(Annual Mean)**



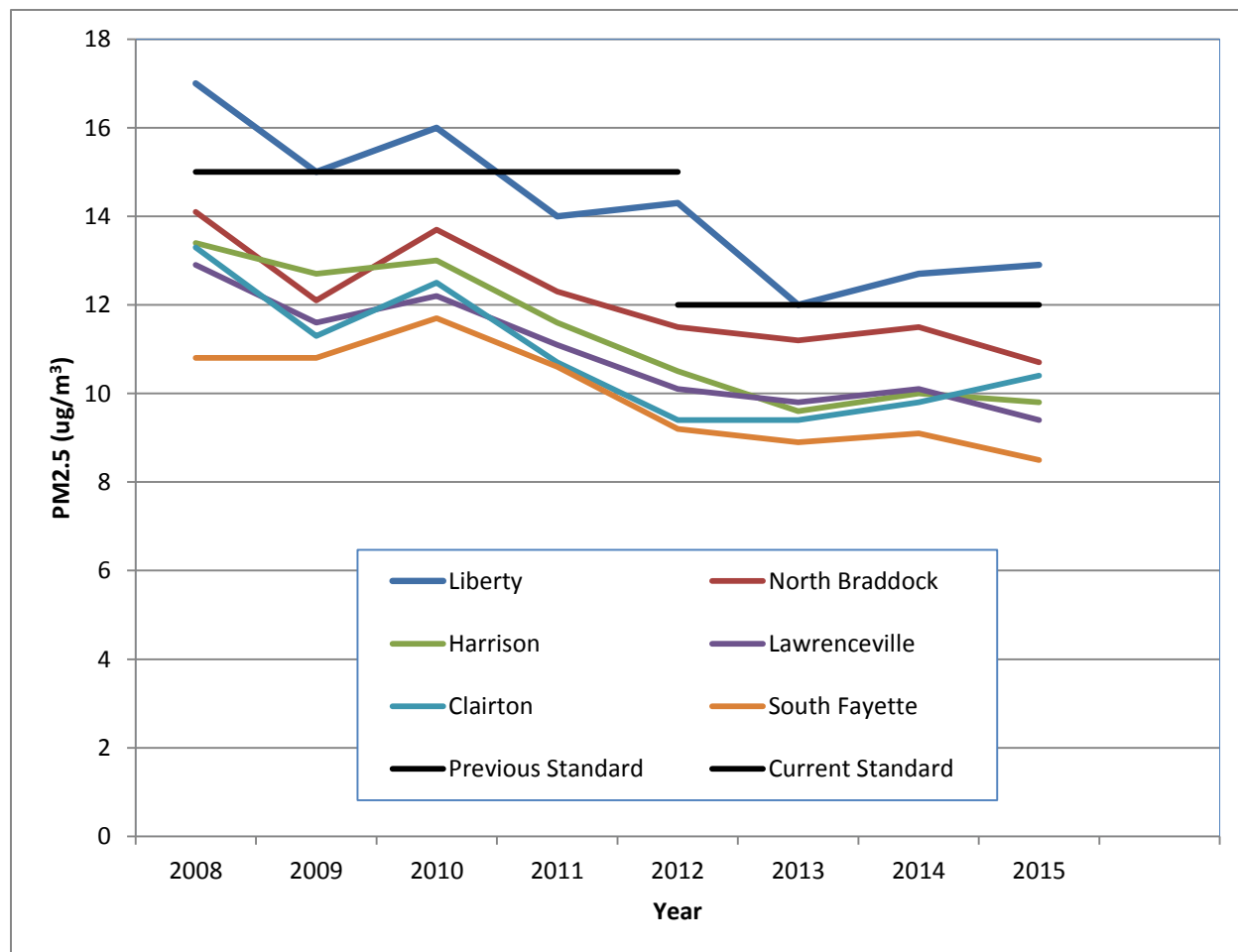
**Table 7. Michigan's 5-year Monitored Trends for Annual NO₂
(Annual Mean - ppb)**

	Lansing	Houghton Lake	East 7 Mile	Howell – Near Road	Howell - Downwind
2011 Annual Mean	7.45	1.01	12.07	18.67*	12.86*
2015 Annual Mean	6.94	1.37	11.29	18.13	12.42
Change	-0.51	+0.36	-0.78	-0.54	-0.44
Percent Change	-6.85%	+35.6%	-6.46%	-2.89%	-3.42%

* First available data - 2012

Finally, Figure 7 shows the downward trend of annual $PM_{2.5}$ in Allegheny County, Pennsylvania. Five of the six monitors in the area are achieving the standard. Table 8 shows the five-year trend for the Allegheny County monitors. USEPA projections are that the sixth monitor (Liberty) will meet the standard by 2017; however, it will be in maintenance status. Continuation of these trends would add support to the determination that the Liberty monitor will be in attainment with the standard in the near future, and Michigan's minor contributions to their $PM_{2.5}$ levels will not hinder the ability of the Liberty monitor to achieve and maintain the 2012 $PM_{2.5}$ NAAQS.

Figure 7. $PM_{2.5}$ Monitored Annual Average Trends in Allegheny County, Pennsylvania



**Table 8. Allegheny County's 5-year Monitored Trends for PM_{2.5}
(Design Values – µg/m³)**

	Liberty	North Braddock	Harrison	Lawrenceville	Clairton	South Fayette
2011 Annual Average	14	12.3	11.6	11.1	10.7	10.6
2015 Annual Average	12.9	10.7	9.8	9.4	10.4	8.5
Change	-1.1	-1.6	-1.8	-1.7	-0.3	-2.1
Percentage Change	-7.9%	-13.0%	-15.5%	-15.3%	-2.8%	-19.8%

Michigan's permanent and enforceable measures to reduce emissions that contribute to maintenance of Pennsylvania monitor.

As shown above, the Liberty monitor is the only monitor listed in the Guidance for which Michigan could have any qualified contribution. The weight-of-evidence analysis supports the assertion that Michigan will not contribute significantly to nonattainment or interfere with maintenance with any of the monitors listed in the Guidance. The MDEQ SIP contains rules R 336.1301 through R 336.1374 to limit emissions of PM throughout the state; R 336.1401 through R 336.1420 and the new R 336.1407 to reduce emissions of SO₂ throughout the state; and R 336.1801 through R 336.1834 to limit emissions of NO₂ throughout the state. Also, the MDEQ recently promulgated and submitted R 336.1430 to the SIP to reduce SO₂ emissions in the Detroit SO₂ Nonattainment Area.

Therefore, based on the weight-of-evidence above, the MDEQ asserts that PM_{2.5} emissions and monitored levels will continue to decline in Michigan and Michigan's impact outside of the state will diminish due to current rules, future regulations, and power plant shutdowns. Additional enforceable measures to reduce Michigan's contribution to the Liberty monitor are unnecessary.

Conclusion

The MDEQ has shown that Michigan has no impact on the nonattainment and maintenance monitors in California and Idaho, and only a slight impact on the Allegheny County, Pennsylvania, Liberty monitor. The weight-of-evidence analysis shows that Michigan's emissions of SO₂, NO_x, and PM_{2.5} are decreasing or remaining stable; the monitored levels of these pollutants in the state are decreasing or remaining stable; and based on wind direction, Michigan does not have a measured impact on the Liberty monitor. It is also clear that any impact that Michigan currently has on the Liberty monitor will be decreasing over time through current SIP approved rules, new rules, new USEPA fuel standards, and future power plant retirements in Michigan. The preceding analysis gives ample indication that Michigan will not interfere with Pennsylvania's ability to maintain compliance with the PM_{2.5} annual NAAQS by 2017. Through this analysis, Michigan has completed its obligation under the CAA Section 110(a)(2)(D)(i)(I) for the 2012 PM_{2.5} NAAQS.